APPENDIX H

Recommended values of Physical Constants to be Used in ENDF

Sources for Fundamental Constants

The basic source for Fundamental Constants used by CSEWG in evaluating and processing ENDF data are the values reported in **1998 CODATA internationally recommended values of the Fundamental Physics Constants** (Source 1) as taken from the NIST Reference on Constants, Units, and Uncertainties Web site[1].

These are supplemented by the mathematical constants from **MathSoft[2]** (Source 2).

Atomic masses not given in the CODATA recommended values should be taken from the **Atomic Mass Tables** of G. Audi and A. Wapstra[3] (Source 3).

[1] The information was prepared by P. J. Mohr and B. N. Taylor, "The 1998 CODATA Recommended Values of the Fundamental Physics Constants," Version 3.1, National Institue of Standards and Technology (December 1999). The Web site is located at http://physics.nist.gov/cuu/Constants/.

[2] The information was prepared by Steven Finch of MathSoft, Inc., for their Web site which is located at http://www.mathsoft.com/asolve/constant/constant.html.

[3] G. Audi and A. H. Wapstra, Nucl. Phys. A. 595, 409 (1995). The Web site, maintained by the Atomic Mass Data Center, is located at http://csnwww.in2p3.fr/groupes/massatom/masseval.html.

Fundamental Constants and derived data

Values of the Fundamental Physics Constants, as approved by CSEWG, are given in this Appendix. These values should be used until updates are approved by CSEWG.

Values for quantities which are derived from these fundamental constants, and which were previously given in the body of this manual, are also presented in this section with the expressions by which they have been replaced in the body of this Manual. These values may not appear in subsequent revisions of this Appendix.

Use of fundamental constants by code developers

Code developers are encouraged to locate any values for fundamental physics constants that may be currently buried deep within their codes, and to replace these values by the expressions given here; the values would then be specified in only one location in the code. This ensures internal consistency, and expedites any necessary updates.

Code developers should double-check that numerical constants (e.g., π or e) are represented to a degree of accuracy consistent with the precision of the computers on which the codes are to be run.

In subsequent revisions of this manual, values for derived quantities may not be given. Instead, code developers should calculate those quantities by directly evaluating the expressions. This will ensure that values are as precise as the computer permits.

Use of fundamental constants by evaluators

Evaluators should use the fundamental constants, mass numbers, Q-values, etc., as specified in this section, for evaluations submitted for acceptance by ENDF.

Evaluators are encouraged to specify values for “hidden” physical constants within the File 1 comments of the ENDF file in order to prevent future confusion in the event of changes in the accepted values.

Table 1: Fundamental Constants

Expression	Definition	Numeric value	Source
e	natural logarithmic base	2.718 281 828 52	2
π	Archimedes' constant	3.141 592 653 59	2
e	elementary charge	$1.602\ 176\ 462 \times 10^{-19}$ C	1
$\alpha^{-1} = \hbar c / e^2$	inverse fine-structure constant	137.035 999 76	1
u	atomic mass constant (amu)	$931.494\ 013 \times 10^{6}$ eV	1
h	Plank's constant	$4.135\ 667\ 27 \times 10^{-15}$ eV s	1
$\hbar$	Planck's constant/2π	$6.582\ 118\ 89 \times 10^{-16}$ eV s	1
k	Boltzmann's constant	$8.617\ 342 \times 10^{-5}$ eV K^{-1}	1
c	speed of light (in vacuum)	299 792 458 m s^{-1}	1
N_A	Avogadro's number	$6.022\ 141\ 99 \times 10^{23}$ mol^{-1}	1

Table 2. Masses

Expression	Definition	Numeric value	Source
m_n	neutron mass	1.008 664 915 78 amu	1
m_e	electron mass	$5.485\ 799\ 110 \times 10^{-4}$ amu	1
m_p	proton mass	1.007 276 466 88 amu	1
m_d	deuteron mass	2.013 553 212 71 amu	1
m_t	triton mass	3.016 049 268 amu	3
m_{3He}	^{3}He mass (hellion)	3.014 932 234 69 amu	1
m_α	α mass	4.001 506 1747 amu	1

Table 3. Energies needed to break particles into their constituent nucleons.

d	deuteron	2.22 MeV
t	triton	8.48 MeV
^{3}He	^{3}He	7.72 MeV
α	alpha	28.3 MeV

Table 4.
Conversion Factors

Convert	Conversion Factor	Source
amu $\rightarrow$ eV	$9.314\,940\,13 \times 10^{8}$	1

The following table gives values which were previously given in the body of this Manual, along with the expressions which should be used in the future for these values. These expressions have been substituted for the values at the appropriate places in the Manual. **These values should not be used in any future applications; instead, please use the values for the Fundamental Constants as specified in this Appendix**. (For example for m_p/m_n, do not use 0.99862; use the value derived from the values for m_p and m_n).

Table 5.
Derived quantities whose values were formerly given in the body of the Manual

Location	Value previously given in Manual	Units for value	Expression
page 0.18	0.998 62		m_p/m_n
	1.996 26		m_d/m_n
	2.989 60		m_t/m_n
	2.989 03		m_{3He}/m_n
	3.967 13		m_a/m_n
Page 4.7	3.0560×10^{-8}	1 / (eV barn steradian)	$2\, m_n / (\hbar^2 (4\pi)^2)$
Eq. (6.9)	$4.784\,53 \times 10^{-6}$	$(10^{-12}$ cm$)^2$ eV / amu	$2 / \hbar^2$
Eq. (6.10)	$2.480\,58 \times 10^{4}$	eV / amu	$e^4 / 2\hbar^2 = 1 / (2\alpha^2)$
page D.3	$2.196\,771 \times 10^{-3}$	10^{-12} cm (eV)$^{-1/2}$	$\sqrt{2m_n}/\hbar$